AN EFFECT OF STIMULATED RADIATION PROCESSES ON RADIO EMISSION FROM MAJOR PLANETS. F. V. Prigara, *Institute of Microelectronics and Informatics, Russian Academy of Sciences, 21 Universitetskaya, 150007 Yaroslavl, Russia, (fprigara@imras.yar.ru).*

The standard theory of thermal radio emission encounters some difficulties. The most crucial one is non-possibility to explain the radio spectrum of Venus in the decimeter range [3]. The radio spectra of planetary nebulae at high frequencies also are not comfortably consistent with the standard theory [6]. Here we show that the account for an induced character of radiation processes sufficiently improves the predictions of the standard theory.

It was shown recently [5] that thermal radio emission has a stimulated character. According to this conception thermal radio emission from non-uniform gas is produced by an ensemble of individual emitters. Each of these emitters is a molecular resonator the size of which has an order of magnitude of mean free path *l* of photons

$$l = \frac{1}{n\sigma} \tag{1}$$

where *n* is the number density of particles and σ is the absorption cross-section.

The emission of each molecular resonator is coherent, with the wavelength

$$\lambda = l, \tag{2}$$

and thermal radio emission of gaseous layer is incoherent sum of radiation produced by individual emitters.

The condition (2) implies that the radiation with the wavelength λ is produced by the gaseous layer with the definite number density of particles *n* .

The condition (2) is consistent with the experimental results by Looney and Brown on the excitation of plasma waves by electron beam [8,9]. The wavelength of standing wave with the Langmuir frequency of oscillations depends on the density as predicted by equation (1). The discrete spectrum of oscillations is produced by the non-uniformity of plasma and the readjustment of the wavelength to the length of resonator. From the results of experiment by Looney and Brown the absorption cross-section for plasma can be evaluated.

Let us apply the above-formulated condition for emission to the atmosphere of planet. In this case the number density of molecules *n* continuously decreases with the increase of height *h* in accordance with barometrical formula

$$n = n_0 exp(-\frac{mgh}{kT}) \tag{3}$$

where m is the mass of molecule, g is the gravity acceleration; k is the Boltzmann constant (e.g., [1]). Here the temperature of atmosphere T is supposed to be constant. In fact the temperature changes with the increase of height, so the formula (3) describes the change of molecule concentration in the limits of layer, for which we can consider the temperature to be approximately constant (the temperature changes with the increase of height essentially slower than the concentration of molecules).

If the emitting particles are the molecules of definite sort, then their number density is monotonously decreasing with the increase of height. Therefore, according to the condition for emission (1), the radio waves with the wavelength λ are emitted by the gaseous layer, located at well-defined height *h* in atmosphere. Thus, the relation between the brightness temperature of radio emission and wavelength $T(\lambda)$ reproduces (partially or in whole) the temperature section across the atmosphere *T(h)*.

This is the case for the Venus atmosphere. Here the emitting particles are the molecules of CO_2. This oxide of carbon is the main component of Venus atmosphere, its contents being 97%. The data concerning the brightness temperature of radio emission from Venus are summarized in [4].

Assuming $\sigma = 10^{-15} cm^2$ and using the condition for emission (1), we can find the number density of emitting molecules *n* in the gaseous layer, which emits the radio waves with given wavelength λ. Then, with the help of barometrical formula (3) and the data upon the pressure and the temperature in the lower layer of Venus atmosphere [1], we can establish the height of emitting layer in the atmosphere. This procedure gives the temperature section of Venus atmosphere similar to those of Earth's atmosphere. It is not in contradiction with the data received by the means of spacecrafts Venera, since on these apparatus the temperature was measured only in the limits of troposphere, up to the height 55 km.

Though the direct measurements of a temperature profile at the heights of 100 to 160 km are absent, the electron density profile for these heights is available [3]. Using the theory of thermal ionization [7], one can see that the night profile of electron density is in agreement with the temperature profile derived in the present paper.

Quite similarly the brightness temperature of Jovian thermal radio emission in the range of 0.1 cm to 4 cm as a function of wavelength [2,4] reproduces the temperature section of Jovian atmosphere. In this case the temperature structure of atmosphere also is similar to those of Earth's atmosphere: there are two minimums of temperature (tropopause and mesopause) and one intermediate maximum (mesopeak).

The observational data concerning the thermal radio emission of Mars, Saturn, Uranus and Neptune are not so complete as in the case of Venus and Jupiter. These data, however, are in agreement with Earth type temperature structure of atmosphere. In the case of Mars the measurements of pressure and temperature in the lower layer of atmosphere are available [1], so one can reproduce using the radio emission data the temperature section of Mars atmosphere. Here the emitting particles are the CO_2 molecules as in the case of Venus atmosphere.

The intermediate maximum of temperature in the region of mesopeak perhaps can be explained by absorption and next re-emission of infrared radiation transferred from the lower layers of atmosphere [1].

If the planetary atmosphere is sufficiently dense, the own thermal radio emission from the solid surface of the planet is quenched, and only the radio emission from the planetary atmosphere is observed. In accordance with equations (1) and (2), the condition for the quenching of thermal radio emission with the wavelength λ from a solid surface in a dense atmosphere is as follows

$$n_0 > \frac{1}{\lambda\sigma} \tag{4}$$

where n_0 is the number density of molecules nearby the solid surface. The condition (4) is valid both for Venus and Mars at radio wavelengths.

Equation (4) determines the quenching of thermal emission from the solid surface in the gaseous atmosphere in the whole Rayleigh-Jeans region of spectrum, not only in the radio band.

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